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SUBSTRATE ASSEMBLING DEVICE

[Abstract]

PROBLEM TO BE SOLVED: To provide a substrate assembling device which can align substrates with high accuracy within a vacuum chamber without damaging the substrates and can rapidly bond the substrates to each other.

SOLUTION: A single table 8 or freely attachably and detachably fastening either one of the substrates 1A and 1B is arranged in the vacuum chamber 100 and there are arms extending in the respective directions of X and Y at the flank sections of the table from each of the actuators 9 and 10 arranged outside the vacuum chamber. The table is adapted to be horizontally moved in the respective directions

of X and Y and θ via the arms by the actuation of the respective actuators and further a pressurizing plate 27 for freely attachably and detachably fastening the other of the substrates is arranged within the vacuum chamber. The substrate assembling device bonds both substrates by horizontally moving the table by means of the respective actuators to align the substrates to each other and moving the pressurizing plate toward the table.

[Claim(s)]

[Claim 1] A substrate assembling apparatus which holds substrates that are to be adhered to be faced up and down of each other, narrows a spacing while positioning and adheres both substrates in a vacuum with an adhesive applied to any one of the substrates, wherein a single table which fixes any one side of said substrates to a surface or a lower face to be attached and detached freely is arranged in a vacuum chamber, arms are extended in each directions of XY to the lateral portion of said table from each of a plurality of actuators arranged on the outside of said vacuum chamber, each arms has an edge which can be slid in the lateral portion of a table to a motion of other cross directions of XY, said table can be horizontally moved in each directions of XY and θ through an arm by actuation of each of said actuator, a pressurization plate which fixes another side of said substrates to a more lower face or surface to be attached and detached freely is arranged in said vacuum chamber to horizontally move said table by each of said actuators to perform the positioning of the substrates each other, and then said pressurization plate is moved to the direction of said table to narrow the spacing of both of the substrates to adhere to both substrates.

[Claim 2] The substrate assembling apparatus of claim 1, wherein the vacuum

chamber consists of an upper chamber and a lower chamber, and said pressurization plate or table is internally containedin the upper chamber and said table or pressurization plate is internally containedin the lower chamber.

[Claim 3] The substrate assembling apparatus of claim 2, wherein the pressurization plate or table internally contained in the upper chamber has a means for vacuum-adsorbing said plate and a means for electrostatically adsorbing said table.

[Title of the invention]

SUBSTRATE ASSEMBLING DEVICE

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to a substrate assembling apparatus which holds substrates to be adhered to be faced up and down each other and narrows a spacing while positioning to adhere the substrates.

[Description of the Prior Art]

In manufacturing a liquid crystal display panel, there is a process which adheres two glass substrates having mounted a transparent electrode and thin film transistor array with an adhesive (henceforth called a sealing agent) with a spacing closed extremely of about several µm (henceforth, the substrate after adhesion is called a cell) to seal a liquid crystal in a space formed.

In Japanese Patent Laid-Open No. 1998-26763, there is proposed a process which comprises performing a sealing of this liquid crystal to drop the liquid crystal on the lower substrate patterned with a pattern closing a sealing agent without forming an inlet, maintaining the upper substrate in a vaccum chamber on a pin to arrange on the upper part, positioning an upper substrate manually, and then,

descending the pin to contact the upper and lower substrates to performing adhesion by pressurizing the upper and lower substrates using a pressure difference upon contacting by by leaking a vacuum.

[Problem to be Solved by the Invention]

In the above-mentioned conventional process, since an upper substrate is held on a pin to perform a positioning to a lower substrate, it is worried about that a transparent electrode, thin film transistor array and the like mounted in the lower face of the upper substrate may be damaged by the pin.

Although it is considerable to arrange the a lower substrate on XYθ table for positioning and not to move the upper substrate, the conventional XYθ table has a constitution that each tables of X, Y, θ are mounted in a multistage pile, driven individually by an actuator and moved in each directions of X, Y, θ , suh constitution has a problem that since the vacuum chamber is large-sized owing to enlargement of a vertical dimension of XYθ table, and also, it takes time for exhausting the gas entered through a narrow spacing of a screw hole, inter-table connecting part and the like, it takes long time until the inside of a vacuum chamber reaches a target degree of vacuum.

The purpose of the present invention is to provide a substrate assembling apparatus which can perform a positioning at higher precision without damaging

substrates in a vacuum chamber to adhere the substrates promptly.

[Means for Solving the Problem]

For achieving the above purpose, the present invention is characterized in that it provides a substrate assembling apparatus which holds substrates to be adhered to be faced up and down each other, narrows a spacing while positioning and adheres both substrate in a vacuum with an adhesive applied to any one of the substrates, wherein the single table which fixes any one side of said substrates to a surface or a lower face to be attached and detached freely is arranged in a vacuum chamber, arms are extended in each directions of XY to the lateral portion of said table from each of a plurality of actuators arranged out of said vacuum chamber, each arms are has the edge which can be slid in the lateral portion of a table to a motion of other cross directions of XY, said table can be horizontally moved in each directions of XY and θ through an arm by actuation of each of said actuator, a pressurization plate which fixes another side of said substrates to a more lower face or surface to be attached and detached freely is arranged in said vacuum chamber to move horizontally said table by each of said actuators to perform the positioning of the substrates each other, and then said pressurization plate is moved to the direction of said table to narrow the faced spacing of both substrates to adhere both substrates.

[Embodiment of the Invention]

Hereafter, an embodiment of the present invention is explained based on drawing.

In Figs. 1 to 4, a substrate assembling apparatus of the present invention consists of a liquid crystal dropping part S1 and a substrate adhesion part S2 and both parts is arranged adjacently on a stand 2. The frame 3 for supporting the substrate adhesion part S2 is arranged on the stand 2. Also, a X stage 4 is mounted on a surface of a stand 2. The X stage 4 can come and go in the left and right X-axial direction in the drawing, i.e., between the liquid crystal dropping part S1 and the substrate adhesion part S2 by a driving motor 5. The lower chamber 6 is fixed on the X stage 4. The ball bearing 7 is installed within the lower chamber 6 and the single (1-stage) table 8 is installed thereon. The arm extended from two actuators 9 fixed to a side of the lower chamber 6 is attached in the X direction of a table 8, i.e., in a side contacted to driving motor 5. Also, although it is not shown, the arm extended from two actuators 10 fixed to a side of the same lower chamber 6 is attached in a side of the Y direction perpendicular to this arm.

Fig. 3 shows an arm 9a or 10a extended from each actuators 9, 10, and the connection part (edge) of T-shaped rail 8a of the table 8.

The table 8 is a square-shaped, T-shaped rail 8a is located in each sides in

each directions of X and Y, and rollers 9b and 10b are mounted in the edge of each arms 9a, 10a to be located between the table 8 and T-shaped rail 8a in each side.

Therefore, when the actuator 10 is fixed, and the actuator 9 tends to move in front and rear the arm 9a in the X direction to move the table 8 in the X direction, the roller 10b of arm 10a connected to the actuator 10 is rotated so the arm 10a slides only to the table 8 without restricting by the actuator 10 to move table 8 in the X direction. Also, in the reversed case, the table 8 can be moved in the Y direction. When changing the movement magnitudes of actuators 9 and 10 are changed by only a suitable level simultaneously, the table 8 can be rotated in the θ direction.

Therefore, the table 8 can be freely moved in each direction of X, Y, and θ within the lower chamber 6 independently to the X stage 4].

The adsorption part 11 which carries lower substrate 1A is mounted on the table 8.

The liquid crystal dropping part S1 comprises a dispenser 13 for dropping a desired amount of liquid crystal agent to the lower substrate 1A held on the table 8a, a Z-axis stage 14 for moving up and down the dispenser 13, a motor 15 for driving the Z-axis stage 14, a Y-axis stage 16 for moving perpendicularly a dispenser 13 together with Z-axis stage 14 to a X-axis stage 4 and a motor 17 for driving the Y-axis stage 16, and is fixed to the frame 3.

The desired amount of liquid crystal agent is dropped to an optional part on the lower substrate 1A by moving the X stage 4 in the direction of X by the driving motor 5 and moving the dispenser 13 in the direction of Y by the driving motor 17.

The X stage 4 which maintains a loading of the liquid crystal-dropping rear-lower substrate 1A is moved to the lower part of the substrate adhesion part S2 by the driving motor 5.

In the substrate adhesion part S2, the upper chamber 21 has a structure that the pressurization plate 27 and electrostatic adsorption plate 28 within the upper chamber 21 can move up and down independently each other. That is, the upper chamber 21 has a housing 30 containing internally a linear bush and a vacuum seal and moves to the up-and-down Z-axis direction by a cylinder 22 fixed to the frame 3 by using a shaft 29 as a guide.

When the X stage 4 is moved to the substrate adhesion part S2 to descend the upper chamber 21, a flange of the upper chamber 21 is contacted to and is united with O ring 44 arranged around the lower chamber 6, and at tis time, it functions as a vacuum chamber 100.

Since the housing contains internally the vacuum seal which can move up and down without vacuum leakage to a shaft 29, although the upper chamber 21 forms and deforms the vacuum chamber 100 to the lower chamber 6. The

deformation of the vacuum chamber can give a force given to a shaft 29 to prevent a deformation of the pressurization plate 27 fixed to the shaft 29 to hold the electrostatic adsorption plate 28, so the upper substrate 1B held on the electrostatic adsorption plate 28 and the lower substrate 1A held on the adsorption part 11 of the table 8 are maintained in parallellel to be able to adhere each other, as mentioned hereinafter.

23 is a vacuum valve and 24 is a piping hose, and they are connected to a vacuum source and used when decompressing the vacuum chamber to vacuum. Also, 25 is a gas purge valve and 26 is a gas tube, and they are connected to a pressure source such as N_2 , a clean dry air and the like and used when returning the vacuum chamber to atmospheric pressure.

The upper substrate 1B is held to adhere closely the lower face of the electrostatic adsorption plate 28, hoever, the upper substrate 1B is not held on the electrostatic adsorption plate 28 by vacuum adsorption under atmosphere. That is, 41 is a joint for vacuum adsorption and 42 is a suction tube, and they are connected to a vacuum source (not shown), and on the electrostatic adsorption plate 28, a plurality of suction holes connected thereto is mounted.

Also, when a surrounding is an atmosphere, the electrostatic adsorption may be used in parallel, and when an electrostatic adsorption force is high, large,

the vacuum adjorption may be not used.

The electrostatic adsorption plate 28 is mounted on the pressurization plate 27 supported by the shaft 29 and the shaft 29 is fixed to a housing 31. The housing 31 is mounted in a linear guide 34 in the frame 3 so that the electrostatic adsorption plate 28 can be moveb up and down. The down driving is performed by a motor 40 fixed on a frame 35 connected to the frame 3 with a bracket 38. Transmission of driving to a nut housing 37 is performed with a ball screw 36.

The nut housing 37 is connected to the housing 31 through a load meter 33 to operate unitedly with the electrostatic adsorption plate 28 in its lower part.

Therefore, the shaft 29 is descended by the motor 40, the electrostatic adsorption plate 28 holding the upper substrate 1B is descended, and the upper substrate 1B is adhered closely to the upper and lower substrate 1A of the table 8 and can give a pressurization force. In this case, the load meter 33 acts as a pressurization force sensor, and by controlling the motor 40 based on feedback signals in order, the desired pressurization force can be applied to the upper and lower substrates 1A, 1B.

Although, as the lower substrate 1A is a loading of the gravity direction, it is enough to fix a positioning by the horizontal direction pressure of a pressing roller 82 to a positioning member 81 mounted in the adsorption part 11 of the table 8 as

shown in Fig. 4, when positioning minutely just before adhesion, since it may be possible that the lower substrate 1B may be got wrenched or raised under an effect that the upper substrate 1B is contacted to the sealing agent od liquid crystal agent on the lower substrate 1A, or during decompressing the vacuum chamber 100 to vacuum, the air entered between the lower substrate 1A and the adsorption part 11 of the table 8 is exhausted so the lower substrate 1A may be got wrenched, it is preferable for the adsorption part 11 to have a function of electrostatic adsorption. And, where a pin which can move to up-and-dowon Z-axial direction is mounted and grounded on the table 8, an anti-electrification of the cell and a cell exclusion from the table 8 after adhesion of the substrates can be performed easily.

60 shown in Fig. 4 is a resin bath which receives the descended the upper substrate 1B in the location slightly under the electrostatic adsorption plate 28, in the case that the electrostatic adsorption plate 28 is vacuum-adsorbed and the vacuum chamber is decompressed so the vacuum adsorption force is disappeared and the upper substrate 1B is descended, and is supported in the suspended form by the shaft 59 extended downward in the location of two opposite angles of the upper substrate 1B. In particular, the shaft 59 is vacuum-sealed through a housing of the upper chamber 21 so the rotation and up-and-down movement can be performed independently.

Next, the electrostatic adsorption plate 28 which adsorbs the substrates is explained.

The electrostatic adsorption plate 28 is an insulating plate and has two rectangular depression portions, and flat electrodes internally containedin each depression portions are covered with a dielectric, and the principal plane of the dielectric is the same plane as the lower face of the electrostatic adsorption plate 28. Each covered flat electrodes are connected to the direct current power source of positive/negative(+/-) through the proper switch, respectively.

Therefore, when the positive/negative voltage is applied to each flat electrodes, a negative or the positive charge is induced to the principal plane of the dielectric which is the same plane as the lower face the electrostatic adsorption plate 28 so the upper substrate 1B is adsorbed electrostatically by Coulomb force generated between the transparent electrode film and the upper substrate 1B by these charges. The voltages applied to each flat electrodes may be the same pole, or dipole different each other.

Next, a process which adheres the substrates with the substrate assembling apparatus of the present invention is explained.

First, in the liquid crystal dropping part S1, a jig holding the upper substrate 1B is loaded in the adsorption part 11 of the table 8 and the X stage 4 is moved to

the substrate adhesion part S2 by a driving motor 5. Then, the a pressurization plate 27 or the electrostatic adsorption plate 28 is discended through a shaft 29 by the motor 40 to adsorbe in vacuum the upper substrate 1B and raise to the motor 40, and the upper substrate 1B is made into a standby condition.

The X stage 4 returnes to the liquid crystal dropping part S1, the empty jig is removed, the lower substrate 1A is loaded on the table 8, nd as shown in Fig. 4, by pressing in the horizontal direction by the prssing roller 82 to the positioning member 81, a desired position is fixed and maintained.

Although not shown in Fig. 2, there is a dispenser which withdraws the sealing agent in the Y-axis stage 14, and when withdrawing the sealing agent while moving the lower substrate 1A in the X direction and the sealing agent dispenser in the Y direction of by the driving motor 5, the sealing agent can be patterned in the pattern closed on the lower substrate 1A.

Then, the liquid crystal agent is dropped on the lower substrate 1A from the dispenser 13. In this case, the sealing agent becomes a dam and the dropped liquid crystal agent is not swept away.

Next, the X stage 4 is moved to the substrate adhesion part S2, the upper chamber 21 is discended to a cylinder 22 to contact its flange to O ring 44, and the vacuum chamber 100 is formed with the lower chamber 10 as shown in Fig. 1.

And, the vacuum valve 23 is opened to decompress the inside of the vacuum chamber 100.

Since the table 8 has a single configuration, this decompression has no problem that air is leaked from a fine part with complicated constitution by a conventional multistage pile, and reaches a desired degree of vacuum promptly

Since the upper substrate 1B is in the state cacuum-adsorbed to the electrostatic adsorption plate 28 upon decompressing, when the the decompression is progressed to proceed with the vacuation within the chamber, the vacuum adsorption force which was acting on the upper substrate 1B is disappeared so the the upper substrate 1B is discended by it self-weight. The discended substrate is received in the resin bath 60 as shown in Fig.4 and is held in the location slightly under of the electrostatic adsorption plate 28 as shown in Fig. 5.

At the time that the vacuum chamber 100 becomes a vacuum sufficiently, a voltage is applied to the electrostatic adsorption plate 28 and the upper substrate 1B of the resin bath 60 is sucked in and maintained in the electrostatic adsorption plate 28 by Coulomb force.

In this case, since it is already a vacuum, air is not remained between the electrostatic adsorption plate 28 and the upper substrate 1B, and when the air

escapes, the upper substrate 1B is not be got wrenched. It is more important that the upper substrate 1B is adhered closely to the electrostatic adsorption plate 28, without intervening air therebetween. Accordingly, a discharging is not generated with an induction charge.

When the discharging is generated in the state of remaining with, the air may be extended to separate the upper substrate 1B from the electrostatic adsorption plate 28 or destroy the pattern on the upper substrate 1B, however, according to the embodiment of the present invention, since air is not remained, such abnormal circumstances are not occurred.

Thereafter, the shaft 59 is discended by a rise-and-fall actuator, and then, the shaft 59 is rotated by a rotation actuator so that the resin bath 60 does not block the adhesion of both the upper and lower substrates 1A, 1B, and thereafter, the pressurization plate 27 is discended by the motor 40 to control the motor 40 while measuring a pressurization force with a load meter 33 to adhere both the upper and lower substrates 1A, 1B in a desired spacing.

In this case, since the upper substrate 1B is adhered closely to the electrostatic adsorption plate 28 so the center part is not hung down, the spacer in a liquid crystal agent has adversely effected, or the positioning of substrates each other does not become impossible. Also, since both the upper and lower substrates

1A, 1B are maintained in parallel and are suitable for pressurization, there is no possibility that a leak part in the joint by the sealing agent and throwing awy it, and also while sealing the liquid crystal agent between both the upper and lower substrates 1A, 1B, the outer air is not invaded to form a void and block a display function.

As shown in Fig. 5 R > 5, the positioning of both the upper and lower substrates 1A, 1B is performed at higher precision, by reading the positioning mark mounted in each upper and lower substrates 1A, 1B by the image recognition camera 32 mounted on the shaft 29 from a perforation 21a formed in the upper chamber 21 to measure a location by the image processing and moving minuately the table 8 by the actuators 9, 10. In this case, in this minute movement positioning that is damaged since both the upper and lower substrates 1A, 1B are held without contacting the opposed faces which can be adhered with anything, since the table 8 is in the vacuum chamber 100 and the upper and lower chambers 6, 21 are not moved, the degree of vacuum in the vacuum chamber 100 can be maintain.

When the adhesion is completed, the vacuum valve 23 is closed and the gas purge valve 25 is opened to suppy N_2 or a clean dried air into the vacuum chamber 100, return to an atmospheric pressure, and thereafter, the gas purge valve 25 is closed, the upper chamber 21 is raised to the cylinder 22 to return the X

stage 4 to the liquid crystal dropping part S1 and a cell is removed from the table 8 to prepare for next adhesion.

Then, since the cell after adhesion may be charged, after carrying out electric discharge processing such as contacting the grounded electric discharging bar or applying ion wind, it is good to remove the cell from the table 8. In the cell removed from the table 8, the sealing agent is hardened with a downstream UV light irradiation device, a heating device and the like.

In the above embodiment, since the adhesion is performed immediately after withdrawing a sealing agent and dropping liquid crystal, the production yield can be improved since it is very difficult for a dust to be deposited on the substrates. Also, since the X stage 4 can be used for conveying the upper substrate 1B into the vacuum chamber 100 of upper substrate 1B, the miniaturization of the apparatus is devised. Also, as the X stage 4 is used as a single stage, the volume in a vacuum chamber can be minimized, wherby a target degree of vacuum can be reached promptly.

The present invention is not limited to the above-mentioned embodiment and may be carried out as follows.

(1) The supply of the upper substrate 1B to the electrostatic adsorption plate 28 may be carried out by mounting on X stage a plurality of resin baths

(corresponding to the resin bath 60 of Fig. 4) which can be expanded and contracted in the up-and-dpwn direction, receiving the upper substrate 1B on the plurality of resin baths when the X stage 4 is in the liquid crystal dropping part S1 and moving the X stage 4 to the substrate adhesion part S2.

(2) The suction adsorption to the electrostatic adsorption plate 28 may be carried out directly from a robot hand.

(3) The resin bath mounted on the X stage 4 explained in the above (1) may receive the upper substrate 1B discended when the decompression is proceeded with.

(4) It is allowed to press the upper substrate 1B to the electrostatic adsorption plate 28 before the upper substrate 1B is discended to the resin bath of Fig. 4 or the resin bath mounted on the X stage 4 explained in the above (1), proceeding with the decompression in the state of sucking and adsorbing to the electrostatic adsorption plate 28 and changing to the electrostatic adsorption. In this case, the air between the upper substrate 1B and the electrostatic adsorption plate 28 can be exhausted with decompression, by making the upper substrate 1B not to be adhered closely to the electrostatic adsorption plate 28 physically.

(5) Using the resin bath of Fig. 4 or the resin bath mounted on the X stage 4 explained in the above (1), the upper substrate 1B is held in the location slightly

apart from the electrostatic adsorption plate 28, and the electrostatic adsorption may be performed during the decompression is proceeded with without a vacuum adsorption.

(6) Although two angular portions (two corners which constitute an opposite angle) of the upper substrate 1B are held by the resin bath in Fig. 4, it is allowed that four angular portions (four corners) of the upper substrate 1B are held, or four sides of the upper substrate 1B or two longitudinal sides or two width sides is held by a proper means.

(7) Since it is enough for arms 9a, 10a and a table 8 to move perpendicularly to a mounted direction of arms 9a, 10a, things which is slidable easily such as Teflon and the like, instead of the rollers 9b, 10b fixed to arms 9a, 10a, may be used for the connection part of arms 9a, 10a and a table 8,.

(8) Since it is enough for the table 8 is slidable within the lower chamber 6, where Teflon (registered trademark) and the like is adhered to the lower face of the table 8, a ball bearing may be omitted.

(9) Although the illustrated embodiment is explained that the table 8 is in a side of the lower chamber and the pressurization plate 27 is in a side of the upper chamber, and the pressurization plate 27 is discended to adhere both substrates, inversely, it is allowed that the table 8 is in a side of the upper chamber side and the

pressurization plate 27 is in a side of the lower chamber and the lower substrate is raised to the upper substrate. In this case, the image recognition camera is in a side lower chamber, and the table 8 of a side of the upper chamber is moved minutely and the positioning is performed.

(10) It is applicable to the adhesion of the substrate, in addition to the manufacture of a liquid crystal display panel.

[Effect of the Invention]

As explained above, according to the present invention, the positioning is performed at higher precision without damaging the substrates in the vacuum chamber, and the adhesion can be performed quickly.

[Brief Description of the Drawings]

Fig. 1 is a schematic diagram of the substrate assembling apparatus which represents an embodiment of the present invention.

Fig. 2 is a drawing showing the situation when opening the vacuum chamber of the substrate assembling apparatus shown in Fig. 1 to set each upper and lower substrates to be adhered each other.

Fig. 3 is a drawing showing the constitution of the table of the substrate assembling apparatus shown in Fig. 1 and the arm for moving horizontally the table.

Fig. 4 is a perspective view showing the situation of holding the upper substrate on the resin bath within the vacuum chamber.

Fig. 5 is a cross-sectional view of the main portions showing the situation of performing the positioning of the upper and lower substrates within a vacuum chamber.

[Meaning of numerical symbols in the drawings]

S2: Substrate adhesion part   1A: Lower substrate

1B: Upper substrate   6: Lower chamber

8: Table

8a: T-shaped rail

9, 10: Actuator

9a, 10a: Arm

9b, 10b: Roller

21: Upper Chamber

23: Vacuum valve

27: Pressurization plate

28: Electrostatic adsorption plate

100: Vacuum Chamber